

ARTICLE 8

PROCEDURES FOR CONNECTIONS

8.0 INTRODUCTION

The connections evaluated in this article are connections between:

- Framing members and walls,
- Diaphragms and walls or frames, and
- Walls or frames and foundations.

Connections between other structural members are discussed in the appropriate article.

8.1 CONNECTION CONCERNS

The evaluation of these specific connections involve review of:

- Lateral support of walls that are perpendicular to the direction of the earthquake ("normal walls"),
- Transfer of shear from diaphragms to shear walls and frames that are parallel to the direction of the earthquake,
- Anchorage of walls and columns to the foundations, and
- Interconnection of elements where failure of connections would jeopardize the system.

8.2 ANCHORAGE FOR NORMAL FORCES

8.2.1 WOOD LEDGERS: The connection between the wall panels and the diaphragm does not induce cross-grain bending or tension in the wood ledgers.

For conforming buildings, the evaluator may consider this condition as mitigated, and no calculations are necessary. The deficiency is in the strength of the wall to diaphragm connection. Report this condition as a deficiency.

8.2.2 WALL ANCHORAGE: Exterior concrete or masonry walls are anchored to each of the diaphragm levels for out-of-plane loads.

For conforming buildings, the evaluator may consider this condition as mitigated, and no calculations are necessary. The deficiency is in the strength of the wall to diaphragm connections. Check that the anchors provides a direct, positive connection between the wall and the diaphragm for forces perpendicular to the face of the wall. Evaluate the wall anchorage, treating the wall as a portion of the building with F_p as the demand.

8.2.3 MASONRY WALL ANCHORS: Wall anchorage connections are steel anchors or straps that are developed into the diaphragm.

For conforming buildings, the evaluator may consider this condition as mitigated, and no calculations are necessary. The deficiency is in the strength of the wall anchors. Evaluate the wall anchorage, treating the wall as a portion of the building with F_p as the demand.

8.2.4 ANCHOR SPACING: The anchors from the floor and roof systems into exterior masonry walls are spaced at 4 feet or less.

For conforming buildings, the evaluator may consider this condition as mitigated, and no calculations are necessary. The deficiency is in the strength or the number of the anchors. Evaluate the wall anchors treating the wall as a portion of the building with F_p as the demand.

8.2.5 TILT-UP WALLS: Precast bearing walls are connected to the diaphragms for out-of-plane loads; steel anchors or straps are embedded in the walls and developed into the diaphragm.

For conforming buildings, the evaluator may consider this condition as mitigated, and no calculations are necessary. The deficiency is in the strength of the wall anchors. Evaluate the wall anchorage treating the load as a portion of the building with F_p as the demand. Check the load path between the wall anchors and the diaphragm cross tie.

8.2.6 PANEL-DIAPHRAGM CONNECTIONS: There are at least two anchors from each precast wall panel into the diaphragm elements.

For conforming buildings, the evaluator may consider this condition as mitigated, and no calculations are necessary. The deficiency is in the number of anchors. Report this condition as a deficiency.

8.2.7 INADEQUATE STIFFNESS OF WALL ANCHORS: Anchors of walls to wood structural elements are installed taut and are stiff enough to prevent movement between the wall and roof.

The deficiency is in the ability of the wall anchor to prevent separations between the wall and roof sheathing that may result in out-of-plane failure of the ledger support. Inspect all anchors too see that they do not have twists, kinks, offsets, or are otherwise installed such that some movement is required before the anchor becomes effective, and that this condition may lead to cross grain bending in the ledger. Conforming buildings which fail this check shall be placed in SPC 4.

8.3 SHEAR TRANSFER

8.3.1 TRANSFER TO SHEAR WALLS: Diaphragms have sufficient capacity and are connected for transfer of loads to the shear walls.

For conforming buildings, the evaluator may consider this condition as mitigated, and no calculations are necessary. The deficiency is in the capacity of the connection to transfer shear. Verify the adequacy of the available diaphragm capacity.

8.3.2 TRANSFER TO STEEL FRAMES: The method used to transfer diaphragm shears to the steel frames is approved for use under lateral loads.

For conforming buildings, the evaluator may consider this condition as mitigated, and no calculations are necessary. The deficiency is in the capacity of the connection to transfer shear. Evaluate the capacity of the load transfer mechanism provided, using AISC design methods or approved manufacturers data. Compare this capacity to the assumed lateral force distribution.

8.3.3 TOPPING SLAB TO WALLS AND FRAMES: Reinforced concrete topping slabs that interconnect the precast concrete diaphragm elements are doweled into the shear wall or frame elements.

For conforming buildings, the evaluator may consider this condition as mitigated, and no calculations are necessary. The deficiency is in the capacity of the connection to transfer shear. Evaluate the capacity of the load transfer mechanism provided. Compare this capacity to the assumed lateral force distribution.

8.4 VERTICAL COMPONENTS TO FOUNDATIONS

8.4.1 STEEL COLUMNS: The columns in lateral-force-resisting frames are substantially anchored to the building foundation.

For conforming buildings, the evaluator may consider this condition as mitigated, and no calculations are necessary. The deficiency is in the strength of the connection between the frame and the foundation. Report this condition as a deficiency.

8.4.2 CONCRETE COLUMNS: All longitudinal column steel is doweled into the foundation.

For conforming buildings, the evaluator may consider this condition as mitigated, and no calculations are necessary. The deficiency is in the strength of the connection between the column and the foundation. Report this condition as a deficiency.

8.4.3 WOOD POSTS: There is positive connection of wood posts to the foundation and the elements being supported.

For conforming buildings, the evaluator may consider this condition as mitigated, and no calculations are necessary. The deficiency is in the strength of the connection between the post and the foundation. Report this condition as a deficiency.

8.4.4 WALL REINFORCING: All vertical wall reinforcing is doweled into the foundation.

For conforming buildings, the evaluator may consider this condition as mitigated, and no calculations are necessary. The deficiency is in the strength of the connection between the wall and the foundation. Report this condition as a deficiency.

8.4.5 SHEAR-WALL-BOUNDARY COLUMNS: The shear wall columns are substantially anchored to the building foundation.

For conforming buildings, the evaluator may consider this condition as mitigated, and no calculations are necessary. The deficiency is in the strength of the connection between the shear wall columns and the foundation. Report this condition as a deficiency.

8.4.6 WALL PANELS: The wall panels are connected to the foundation and/or ground floor slab with dowels equal to the vertical panel reinforcing.

For conforming buildings, the evaluator may consider this condition as mitigated, and no calculations are necessary. The deficiency is in the strength of the connection between the wall panel and the foundation. Report this condition as a deficiency.

8.4.7 WOOD SILLS: All wall elements are bolted to the foundation sill at 6-foot spacing or less with proper edge and end distances for concrete and wood.

For conforming buildings, the evaluator may consider this condition as mitigated, and no calculations are necessary. The deficiency is in the strength of the connection between the wood sill and the foundation. Report this condition as a deficiency.

8.5 INTERCONNECTION OF ELEMENTS

8.5.1 GIRDERS: Girders supported by walls or pilasters have special ties to secure the anchor bolts.

The deficiency is in the strength of the pilaster at the girder anchorage. Report this condition as a deficiency. Conforming buildings that fail this check shall be placed in SPC 4.

8.5.2 CORBEL BEARING: If the frame girders bear on column corbels, the length of bearing is greater than 3 inches.

The deficiency is in the length of bearing. Calculate the interstory drift. Judge the adequacy of the connections to retain their vertical load carrying integrity at a maximum drift estimated to be equal to the drift calculated with the unreduced demand. Conforming buildings that fail this check shall be placed in SPC 4.

8.5.3 CORBEL CONNECTIONS: The frame girders are not supported on corbels with welded elements.

The deficiency is in the strength of the connection. Check all welded connections that transfer lateral loads or are subject to frame action. Determine where connection failures would be brittle (e.g., pull-out of embedded item would occur before yield of mild steel element). Analyze structure for capacity without such connections or check such connections for seismic force amplified by factor $C_d/2$, but not less than 1.5. For connections that can allow the diaphragm to fail in a brittle manner, the R values used in computing the seismic demand shall be consistent with those for brittle systems (not to exceed $R = 2$). Conforming buildings that fail this check shall be placed in SPC 4.

8.6 ROOF DECKING

8.6.1 LIGHT-GAGE METAL, PLASTIC, OR CEMENTITIOUS ROOF PANELS: All light-gage metal, plastic, or cementitious roof panels are properly connected to the roof framing at not more than 12 inches on center.

For conforming buildings, the evaluator may consider this condition as mitigated, and no calculations are necessary. The deficiency is the lack of connection of sufficient strength between the roof panels and the framing elements. Report this condition as a deficiency.

8.6.2 WALL PANELS: All wall panels (metal, fiberglass, or cementitious) are properly connected to the framing.

For conforming buildings, the evaluator may consider this condition as mitigated, and no calculations are necessary. The deficiency is the lack of connections of sufficient strength (to prevent a falling hazard) and flexibility (to allow for the relative displacements between the panel and the supporting frame). Report this condition as a deficiency.